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I. INTRODUCTION

Astronavigational reconnaissance is activities associated with making use of reconnaissance remote sensing devices installed on spacecraft to obtain intelligence related to national security and military activities. Under modern technological conditions--in particular, high technology--it is an important guarantee of maintaining legitmate national rights and interests, protecting national security, and seizing the/164 victory in the war against aggression.

Astronavigational imagery reconnaissance began with aviation reconnaissance. From 1858, when mankind made use of the balloon to obtain the first aerial photograph, until today, there are over 130 years of history. The introduction of aviation at the beginning of the 20th century and the successful launching of artificial satellites at the end of the 1950's made photographic technology like a tiger with wings--doubly strong. As far as the development of modern science and technology is concerned, it also makes traditional photographic techniques shine with new brightness (illegible).

Astronavigational imagery reconnaissance is a modernization of strategic reconnaissance means. As far as astronavigational remote sensing devices are concerned, they are the foundation and key systems associated with implementing astronavigational imagery reconnaissance. We will now take the principal performance indices which astronavigational imagery reconnaissance sensing systems should possess as well as development trends and discuss them respectively below.

II. ANALYSIS OF PERFORMANCE AND TECHNICAL INDICES

1. Spacial Resolution

Speaking in terms of military reconnaissance, remote sensing imagery spacial resolution refers to the minimum dimensions of ground targets which imagery is capable of resolving. Due to the fact that military imagery reconnaissance primarily acquires military targets, military installations, as well as weapons, and so on, the main characteristics of which come from spacial geometrical patterns, resolution, therefore, becomes one of the most primary and most basic technological indices associated with military imagery reconnaissance systems. It is a concentrated manifestation of military imagery reconnaissance system reconnaissance performance.

As far as reconnaissance satellites carrying out different reconnaissance missions is concerned, the imagery remote sensing possesses different resolution requirements. The United Nations weapons examination team investigation report holds that carrying out "general survey" missions requires 3-5m resolutions. Carrying out "detailed investigation" missions, by contrast, requires 0.5-2m resolutions. Moreover, the resolutions required with regard to detailed analysis and description of military

targets should then be within 0.15-0.3m. Research and practical implementation clearly show that 3-10m resolutions are only capable of carrying out "general survey" missions. However, with respect to detailed reconnaissance of military targets, the resolutions must then be better than 1m.

With regard to scanning imagery systems, normally, use is made of "instantaneous field of view" (IFOV) in order to measure and express the reconnaissance performance and resolution capabilities. As far as instantaneous field of view is concerned, it is also called image element resolution and refers to the dimensions of the range of the earth's surface covered by one image element associated with detection devices in an instant of scanning the ground. With regard to the relationship between spacial resolution and instantaneous field of view--in theoretical terms--spacial resolution = $2\sqrt{2}$ times instantaneous field of view. In cases where the standard contrast gradient is 2.5:1, spacial resolution ≈ 2 times instantaneous field of view.

2. Rate of Overlap

Imagery rate of overlap is the ratio between the part of the dimension of the ground area that remote sensing devices repeatedly cover during imagery processes on two adjacent image widths and the dimensions of the image width as a whole in the same direction. Normally, this is expressed as a percentage. It is one of the important technical indices associated with imagery remote sensing devices. It is only so long as remote sensing devices possess adequate rates of overlap that it is then possible to obtain three dimensional imagery. As far as three dimensional images are concerned, they are critically important and indispensible with regard to the interpretation of specially designated military targets and the making of military topographical maps. With respect to astronavigational three dimension reconnaissance imagery, it is possible to obtain it by including longitudinal overlap along the spacecraft orbit and transverse overlap between orbits perpendicular to the direction of spacecraft flight. Generally speaking, astronavigational remote sensing imagery possessing 60% rate of overlap is capable of satisfying the requirements associated with the three dimensional interpretation of military targets and the making of military topographical maps.

3. Orbit Coverage Periods and Revisit Capabilities

In reconnaissance space, one possesses a global reconnaissance capability. In reconnaissance time, one possesses all weather repeated reconnaissance capabilities with regard to key areas and key targets within short periods. This is one of the most outstanding characteristics of astronavigational reconnaissance. It is also a most basic requirement with respect to astronavigational imagery remote sensing devices.

In order to realize global coverage, reconnaissance satellites generally opt for the use of geopolar orbits or quasi geopolar orbits. Moreover, in order to carry out contrasting and mosaic in respect to imagery associated with the same area, it is

then best that solar angles of elevation during imagery be the same or basically the same. Therefore, optimal imagery reconnaissance satellite orbits select solar synchronous orbits or quasi solar synchronous orbits. /165

Satellite orbital coverage periods refer to the time required for imagery reconnaissance satellites to cover the globe once. Satellite revisit capabilities--also called satellite repeated reconnaissance periods--refer to the interval between the time periods required for reconnaissance satellites to reconnoiter the same area two consecutive times. They are both important technical indices associated with reconnaissance satellites. In order to obtain timely intelligence associated with a certain key area or key target, and, in conjunction with that, grasp the dynamics and variations of the situation, there is a requirement for satellites to possess the shortest orbital coverage periods and revisit capabilities. In order to realize the objectives above, imagery systems must then have observation functions associated with relatively large field of view angles and adquate slopes. For example, as far as France's SPOT global natural resource satellite is concerned, due to the fact that it is equiped with an HRV scanning imagery system, it is capable, by ground control, of altering the observation angles of planar reflector mirrors, thereby causing satellites to possess unique rapid revisit capabilities and three dimensional observation capabilities. The average for SPOT satellite revisit capabilities is 2.3 days.

4. Efficiency of Information Acquisition

Timeliness and accuracy are the two basic factors associated with intelligence. Speaking in terms of military intelligence, this is especially the case. In particular, under modern conditions where high technology is used in all areas of warfare, the real time characteristics and rapidity associated with astronavigational reconnaissance means then show even more clearly their special place and function.

Since the middle 1970's and early 1980's, the U.S. and the former Soviet Union, one after the other, developed and launched the fifth generation of photographic reconnaissance satellites, that is, digital transmission type imagery reconnaissance satellites. As far as the U.S. "KH-11" imagery reconnaissance satellite is concerned, from carrying out the taking of photographs in orbit to the sending of intelligence obtained into the hands of the highest policy makers at the White House and the Pentagon, the entire period still did not take an hour. It was completely possible to "reach early warning objectives".

5. Maneuver Reconnaissance and Emergency "Quick Check" Capabilities

Maneuver reconnaissance--also called maneuver orbital change reconnaissance or orbital maneuver reconnaissance--refers to reconnaissance the carrying out of which opts for the use of methods associated with the alteration of satellite orbits in order to acquire the status and changes associated with a certain area or target. With regard to emergency "quick check"

capabilities, they refer to reconnaissance which is carried out with respect to areas or targets needing to be reconnoitered within a short time period based on requirements. Satellite maneuver reconnaissance and emergency "quick check" capabilities depend primarily on satellite orbit changes in order to be realized. In the 1970's, the former Soviet Union launched a type of photographic reconnaissance satellite called the "quick check satellite". In reality, it was nothing else than a third or fourth generation photographic reconnaissance satellite. It was simply aimed at opting for the use of different operating orbits with respect to different reconnaissance targets. As soon as reconnaissance missions were completed, it was immediately recovered.

III. DEVELOPMENT DIRECTIONS AND TRENDS

(1) Take intelligence as central. Take improving resolution as key. Unify planning taking everything into consideration. Integrate and optimize. Develop in a comprehensive way and improve system reconnaissance performance. It goes without saying, the final objective of astronavigational reconnaissance and its greatest benefit is the acquisition of large amounts of high quality astronavigational reconnaissance intelligence. It is necessary, in the thinking of the leadership, to really plant the concepts of taking intelligence as central, taking the improvement of imagery remote sensing system resolution as key, and the comprehensive development and improvement of system reconnaissance capabilities.

(2) The installing of multiple types of reconnaissance remote sensing equipment on the same remote sensing platform is a necessity for the development of astronavigational reconnaissance remote sensing. Following along with the development of modern science and technology, take such reconnaissance remote sensing equipment as optical photography, photoelectric imagery, radar imagery, and so on, and install it on the same astronavigational platform in order to gradually mature conditions associated with realizing all weather and all climate real time and uninterupted reconnaissance, monitoring, and tracking.

(3) Photoelectric imagery is the main development direction associated with astronavigational imagery reconnaissance in the 1990's. Using electrically charged coupling devices (CCD) as detection devices for digital transmission type imagery reconnaissance satellites will become the main part of astronavigational imagery reconnaissance in the 90's of this century.

(4) Synthetic aperture imagery radar (SAR) will dominate astronavigational military imagery reconnaissance remote sensing at the end of this century and early in the next century. Synthetic aperture imagery radar uses the possessing of no limitations imposed by the conditions of darkness at night or such weather conditions as overcast, rain, fog, and haze, and, in conjunction with this, the possession of certain penetration

capabilities with regard to the surface of the earth and the surface of water, to become a crack force for astronavigational imagery reconnaissance remote sensing. At the present time, as far as test production and development of space based synthetic aperture imagery radar is concerned, it has already and is in the midst of becoming an important objective pursued by various space faring great powers and organizations. /166

(5) In regard to imagery optical spectrometers, they will make remote sensing technology give rise to revolutionary changes. With respect to optical spectrum imagery techniques, they combine imagery technology and optical spectrum technology in a new type of integrated technique. Its appearance and applications will very, very greatly increase people's capability to classify and identify target objects, making into possibilities the direct presentation of the properties of targets, the indentification of components of the matter composing targets, as well as the amounts of the constituents. There is no need to doubt that it will--together with synthetic aperture imagery radar--dominate the stage in astronavigational imagery remote sensing for the end of this century and the beginning of the next century.

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